AMENDMENTS TO THE DRAWINGS

The attached drawing sheet includes changes to FIG. 1. This sheet, which includes FIG. 1, replaces the original sheet including FIG. 1. In FIG. 1, the caption "Prior Art" has been added.

Attachment: Replacement Sheet

Annotated Sheet Showing Changes

REMARKS

I. Summary of the Examiner's Action

A. Drawing Objections

As set forth on page 2 in paragraph 2 of the May 29 Office Action, the Examiner objected to FIG. 1 and required that a legend such as "Prior Art" be added to the figure.

B. Claim Rejections

As set forth on page 2 in paragraph 4 of the May 29 Office Action, claims 1 – 3, 9 – 10, 12 – 13 and 15 stand rejected under 35 U.S.C. § 102(a) as being anticipated by Applicant Admitted Prior Art (hereinafter "AAPA").

As set forth on page 4 in paragraph 6 of the May 29 Office Action, claims 4, 14 and 17 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over AAPA.

As set forth on page 5 in paragraph 7 of the May 29 Office Action, claims 5 – 8 and 18 – 20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over AAPA in view of United States Patent No. 7,010,016 to Margulis *et al.* (hereinafter "Margulis" or "the Margulis patent".

As set forth on page 8 in paragraph 8 of the May 29 Office Action, claims 11 and 16 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over AAPA in view of

United States Patent Application Publication No. 2006/0291581 to Onggosanusi *et al.* (hereinafter "Onggosanusi" or "the Onggosanusi patent application").

As set forth on page 8 in paragraph 9 of the May 29 Office Action, claim 21 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over AAPA in view of Margulis and further in view of United States Patent No. 7,218,665 to McElwain. (hereinafter "McElwain" or "the McElwain patent").

These rejections are respectfully disagreed with and traversed below.

II. Applicant's Response – Drawing Objections

Applicant has amended FIG. 1 to add the caption "PRIOR ART".

In view of the foregoing, Applicant respectfully requests that the objection to FIG. 1 be withdrawn.

III. Applicant's Response – Prior Art Rejections

A. Rejection of Claims 1 – 3, 9 – 10, 12 – 13 and 15 under 35 U.S.C. § 102(a)

Applicant reproduces claim 1 here as a convenience to the Examiner:

1. A method, comprising:

space-time equalizing the N received signals to generate M output signals from which at least inter-symbol interference is

substantially removed and inter-layer interference is suppressed;

despreading each of the M output signals for generating M soft symbol estimates; and

processing the M soft symbol estimates to derive M final symbol decisions that are made in consideration of modeled residual inter-layer interference present in the space-time equalized M output signals.

Applicant respectfully submits that the subject matter of claims 1, 9 and 15 is neither described nor suggested by AAAP.

In particular, claim 1 recites "processing the M soft symbol estimates to derive M final symbol decisions that are made in consideration of modeled residual inter-layer interference present in the space-time equalized M output signals." It is noted that this step follows steps comprising "space-time equalizing the N received signals to generate M output signals from which at least inter-symbol interference is substantially removed and inter-layer interference is suppressed" and "despreading each of the M output signals for generating M soft symbol estimates."

It is well-known that to establish a proper anticipation rejection each and every element of a claim at issue must be disclosed either explicitly or inherently in a single prior art reference. In rejecting the element of claim 1 corresponding to "processing the M soft symbol estimates to derive M final symbol decisions..." the Examiner stated at page 3, lines 3 – 11:

> "and processing the M soft symbol estimates to derive M final symbol decisions that are made in consideration of modeled residual interference inter-layer interference present in the space-time equalized M output signals (Specification, Page 2, Eq. 1 & Specification, Page 3, Eq. 3 & Specification, Page 4, Eq. 4) {Interpretation: The reference discloses complex weighting factor applied to the signal sample from the received antennas wherein the received vector is modeled using the estimated channel matrix and the weighting is modeling the residual interference since the matrix includes not only the diagonal components but non-diagonal components with id the interference components}."

With all due respect, Applicant concludes from this portion of the rejection of claim 1 that Examiner did not understand the explanation of the prior art as set forth in the background portion of the specification. In particular, equations 3 and 4 respectively concern space and space-time equalization. This is apparent from the accompanying explanation appearing at page 3, line 8 – page 4, line 13 of the Application reproduced here (emphasis added):

> "Fig. 1 illustrates a conventional M-by-N MIMO antenna configuration with M Tx antennas 1 and N Rx antennas 2. In theory, an N-antenna array can cancel out N-1 interfering signals. Thus, an M-by-N MIMO configuration may, in theory, be implemented if $N \geq M$, since each of the M data streams (layers) are interfered by M-1 data streams. A conventional technique to detect layer *m* is to combine antenna signals as:

$$\hat{s}_m(i) = \begin{pmatrix} w^*_{m,1} & w^*_{m,2} & \cdots & w^*_{m,N} \end{pmatrix} \begin{pmatrix} r_1(i) \\ r_2(i) \\ \vdots \\ r_N(i) \end{pmatrix}, \qquad (3)$$

where symbol $w_{m,\,n}$ denotes the complex weighting factor applied to a signal sample from receive antenna n in order to detect transmitted symbol s_m from transmit antenna m. $(\cdot)^*$ and ^ denote complex conjugate and estimate, respectively.

In Eq. 3 a possible despreading operation is neglected for simplicity. It should be noted that to detect symbol interval i, only those signals received during that specific time interval need to be used. Thus, this detection method can be referred to as space-equalization, since the data streams are separated by using spatial processing only. However, the space-equalizer can suppress the interfering data streams completely only in noiseless situation. Especially in the presence of multipath channels the space-equalizer cannot separate the data streams properly. This is because all multipath propagated signals function as additional interfering signals, and the interference cancellation capability of an N-antenna array is exceeded.

In this case, space-time equalization can be applied by setting F_1 and/or F_2 greater than zero:

$$\hat{s}_m(i) = \mathbf{w}_m^H (r_1(i-F_1) \;\cdots\; r_1(i+F_2) \;\; r_2(i-F_1) \;\cdots\; r_2(i+F_2) \;\cdots\; r_N(i-F_1) \;\cdots\; r_N(\quad (4)$$
$$= \mathbf{w}_m^H \mathbf{r}(i)$$

where $(\cdot)^H$ denotes conjugate transpose. Vector $\mathbf{w}_m$ is comprised of complex weighting factors used for combining signal samples from all N antennas from the specified time interval $[i\text{-}F_1,\ i\text{+}F_2]$, as is applied for the detection of the mth data layer.

A goal of space-time equalization is to also remove the inter-symbol interference. The interference suppression is, however, not

> complete, since linear estimation is always a compromise between noise enhancement and interference suppression. That is, a zero-forcing equalizer would be strongly sub-optimal, since completely removing the interference results in an undesirable noise enhancement. Preferably, the linear minimum mean-square error (LMMSE) criterion is applied."

At best for the sake of argument, this subject matter is relevant only to the first sub-element of claim 1 having to do with space-time equalization. It is not seen what relevance the subject matter having to do with space equalization and space-time equalization have to do with the third sub-element of claim 1. There is no teaching, for example, that space-time equalization be performed a second time. In fact, the background material indicates that in the case of space-time equalization the "*interference suppression is, however, not complete, since linear estimation is always a compromise between noise enhancement and interference suppression. That is, a zero-forcing equalizer would be strongly sub-optimal, since completely removing the interference results in an undesirable noise enhancement.*"

Instead, in Applicant's invention, different operations are performed by, in one embodiment, a so-called SPRI ("signal-plus-residual interference") detector. The description of the operations and exemplary SPRI detector appear in the following portion of the specification appearing at page 6, lines 2 – 22 (emphasis added):

> "An improved MIMO receiver in accordance with this invention for receiving an M-by-N MIMO channel includes an N-antenna array at the receiver (preferably diversity antennas or correlation antennas), an M-

output space-time equalizer (preferably linear minimum mean-square error (LMMSE) criterion based) and M correlators, forming a space-time equalizer. The improved MIMO receiver further includes, in accordance with an aspect of this invention, a signal-plus-residual-interference (SPRI) detector. During operation of the SPRI detector the MIMO receiver generates signal models for both the post-equalization desired signal and for the post-equalization interfering signals. Because of the presence of the space-time equalization, it can be assumed that the channel is a 1-tap channel. If there is a substantial amount of residual inter-layer interference, a corresponding inter-layer signal model may be generated as well. Preferably a maximum-likelihood (ML) based detector is applied to the generated signal model. *An aspect the invention is the decoupling the SPRI detector from the space-time equalizer.*

Advantages that are realized by the use of the improved MIMO receiver include a substantial performance improvement over conventional MIMO receivers during use with practical, real-world multipath channels. The use of this invention makes MIMO communication possible with multipath channel environments where conventional MIMO receivers can exhibit severe performance problems. Another advantage is that the improved MIMO receiver is not sensitive to equalizer filter mismatch, as the SPRI detector compensates for any residual inter-layer interference. The use of this invention also enables the MIMO receiver to detect M parallel data streams with N<M Rx antennas."

It is not seen where the operations of Applicant's invention, or of an SPRI receiver operating in accordance with Applicant's invention, is either described or suggested by the AAPA.

Accordingly, Applicant submits that independent claim 1 is patentable over the AAPA. Applicant therefore respectfully requests that the rejection of claim 1 be withdrawn. Applicant also submits that independent claims 9 and 15 are patentable for reasons similar to those set forth above with respect to claim 1 and for reasons having to do with their independently-recited features. As a result, Applicant respectfully requests that the rejection of independent claims 9 and 15 be withdrawn as well. Applicant also requests that the rejection of dependent claims 2 – 3, 10, and 12 -13 be withdrawn, both since these claims depend, either directly or indirectly, from an allowable base claim, and for reasons having to do with their independently-recited features.

B. Rejection of Claims 4, 14 and 17 under 35 U.S.C. § 103(a)

Claim 4 is directed to "a method, as in claim 1, where transmitting occurs at a base station, having the M transmit antennas, where receiving occurs at a mobile station having the N receive antennas, and where N<M." In rejecting the claims, Examiner stated at page 4, lines 19 – 24 that: "However, the AAPA does not explicitly disclose N < M. It would have been obvious to one of ordinary skill in the art at the time of the invention that there is no criticality in selecting more transmit antennas than the receive

antennas, this is matter of design choice depending on the processing power of the mobile station and the reliability of the data received." Applicant would like to remind the Examiner that generally speaking, the fact that an innovation allows a device to be simplified (in this case, by reducing the number of receive antennas) in a manner that was not possible before is often indicia of invention. The Examiner has ignored the portion of the specification that states "The improved MIMO receiver and algorithm in accordance with this invention outperforms conventional MIMO receiver techniques, and also makes it possible to use fewer receive antennas than there are parallel data streams (i.e., N< M). This has generally not been considered to be possible to implement in a practical MIMO receiver system." Accordingly, it is not merely a design choice as claimed by Examiner. Rather, Applicant's invention has made it possible to use fewer receive antennas than possible in the prior art. Accordingly, Applicant respectfully requests that the rejection of claims 4, 14 and 17 be withdrawn.

C. Rejection of Claims 5 – 8 and 18 – 20 under 35 U.S.C. § 103(a)

Applicant submits that independent claims 5 and 18 are patentable for reasons similar to those set forth above with respect to claim 1. The Margulis patent is not seen to remedy the deficiencies identified above with respect to the AAPA. Accordingly, Applicant submits that independent claims 5 and 18, and claims 6 – 8 and 19 – 20, which depend respectively from claims 5 and 18, are patentable over the art of record. Applicant respectfully requests that the rejection of these claims be withdrawn.

D. Rejection of Claims 11 and 16 under 35 U.S.C. § 103(a)

Applicant submits that independent claims 11 and 16 are patentable for reasons similar to those set forth above with respect to claim 1. The Onggosanusi patent is not seen to remedy the deficiencies identified above with respect to the AAPA. Accordingly, Applicant respectfully submits that claims 11 and 16 are patentable over the art of record. Applicant respectfully requests that the rejection of these claims be withdrawn.

E. Rejection of Claim 21 under 35 U.S.C. § 103(a)

Applicant submits that independent claim 21 is patentable for reasons similar to those set forth above with respect to claim 1. The McElwain patent is not seen to remedy the deficiencies identified above with respect to the AAPA. Accordingly, Applicant respectfully submits that claim 21 is patentable over the art of record. Applicant respectfully requests that the rejection of these claims be withdrawn.

III. Conclusion

Applicant submits that in light of the foregoing amendments and remarks the application is now in condition for allowance. Applicant therefore respectfully requests that the outstanding rejections be withdrawn and that the case be passed to issuance.

Respectfully submitted,

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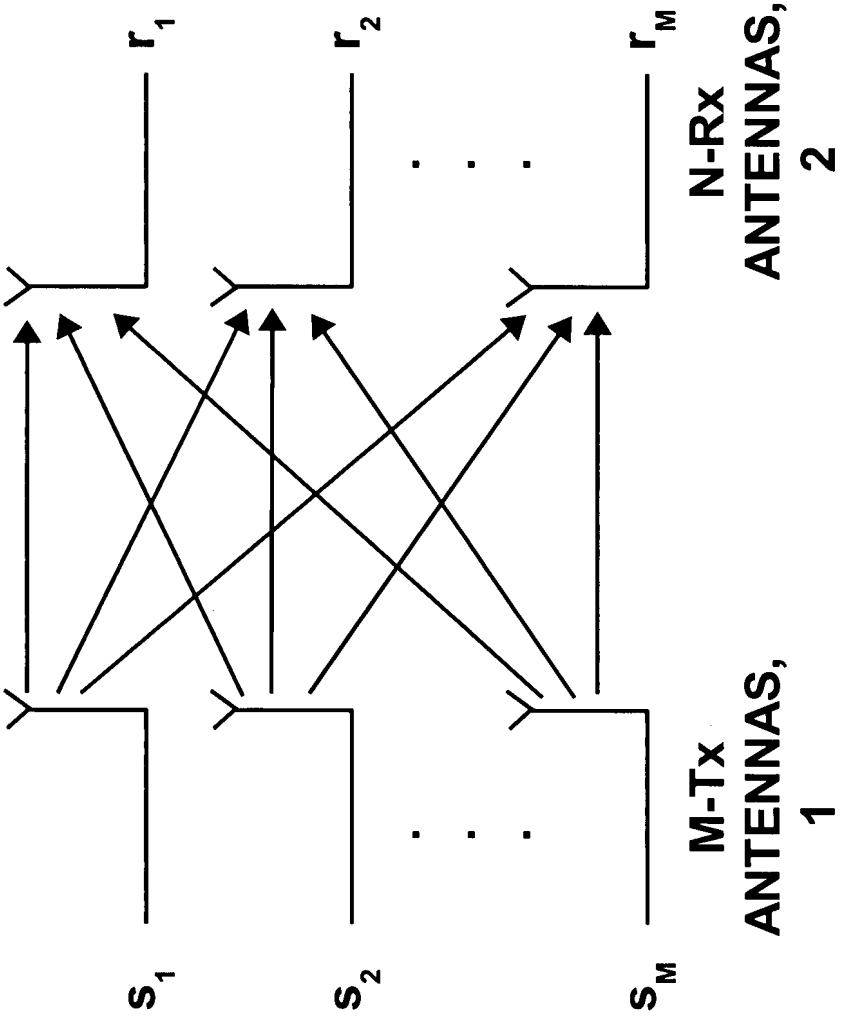

FIG. 1

Added → PRIOR ART